BEES AND WASPS IN THE DIVERSIFIED CONIFEROUS WOODLAND SETTINGS OF BRITISH CENTERPARCS

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ABSTRACT

The potential value of diversified coniferous woodland settings for bees and wasps was revealed by a long-term study of four English Centerparc villages. These collectively produced a list of 259 species (over 50% of the mainland British list) including numerous rarities. Sampling at Elveden Centerparc in Suffolk produced a list of 203 confirmed species making it one of the richest sites for bees and wasps in Britain today. The quantity and diversity of open habitats within a coniferous setting, and their management, have a major bearing on the quality of the bee and wasp fauna. A checklist of management techniques to encourage a diverse bee and wasp fauna in coniferous settings is provided.

INTRODUCTION

Following the end of World War II, large expanses of heathland, moorland and broadleaved woodland (usually ancient) were planted up with serried rows of fast growing conifers in an effort to make Britain self-sufficient in timber. This planting programme resulted in some significant losses of valuable semi-natural habitat, particularly in areas such as Dorset, East Anglia, Nottinghamshire and some other heathland and moorland districts. Sadly, the quality of some of the timber was so poor that financial loss was incurred and there has been a degree of soul searching over certain schemes ever since. For many wildlife groups, including bees and wasps, there are relatively few opportunities in coniferous plantations other than within any rides, or the temporary clearings created by felling and replanting.

In recent years, the Forestry Commission (particularly its Forest Enterprise wing) has declared an intention to restore broadleaved woodland, heathland and other habitats of higher nature conservation and amenity value within areas of coniferous plantation (notably within Dorset and Breckland) as a contribution to the UK BAP targets for Priority Habitats such as Lowland Heathland (UK Government, 1994; UK Biodiversity Steering Group, 1995: Anon, 1998). Conifer removal to create heathland is also a target of several local biodiversity action plans, including those for Dorset, Hampshire and Suffolk.

But how does one go about converting a large, relatively impoverished conifer plantation into an ecologically diverse site supporting a range of habitats with a good range of flora and fauna that includes rare and unusual species? In 1994, the author was commissioned to survey aculeate Hymenoptera and Diptera at Elveden Centerparc, Suffolk. This was the start of an 11-year study that expanded to cover four coniferised Centerparc settings in widely separated parts of England. It has provided an ideal opportunity to answer the above question for bees and wasps within sites that still remain partially coniferised and are also subject to high levels of recreational activity.

METHODS

Study Sites

There are currently four British Centerparcs, all within England:

1. Longleat Forest – located at the eastern end of the Longleat Forest-Longleat Park complex, Wiltshire (ST8342), in plantation woodland dominated by non-native conifers such as silver firs and redwoods. The ground mostly consists of compacted acidic sands and clays, though small patches of more calcareous soil are present. This is the hilliest Centerparc.
2. Elveden Forest, Suffolk (TL8080) (Fig. 1) – located within Thetford Forest, adjacent to Lakenheath Warren SSSI, and close to Wangford Warren which once supported inland mobile dunes. The plantation woodland is dominated by pines and ground conditions comprise mostly loose, chalky sands, producing some dry calcareous grassland, but also some more acidic areas with bracken and limited heathland.
3. Sherwood Forest, Nottinghamshire (SK6268) – as its name suggests is part of the larger Sherwood Forest complex and is dominated by pines on consistently acidic, sandy soils. There is also a small block of semi-natural broadleaved woodland along the entrance drive.
4. Whinfell Forest, Westmorland (NY5227) – formerly known as the 'Oasis', is located within a larger block of coniferous plantation (though less extensive and more isolated than the other sites) which is dominated by pines and features acidic soils that range from compacted sand to peat and loam.

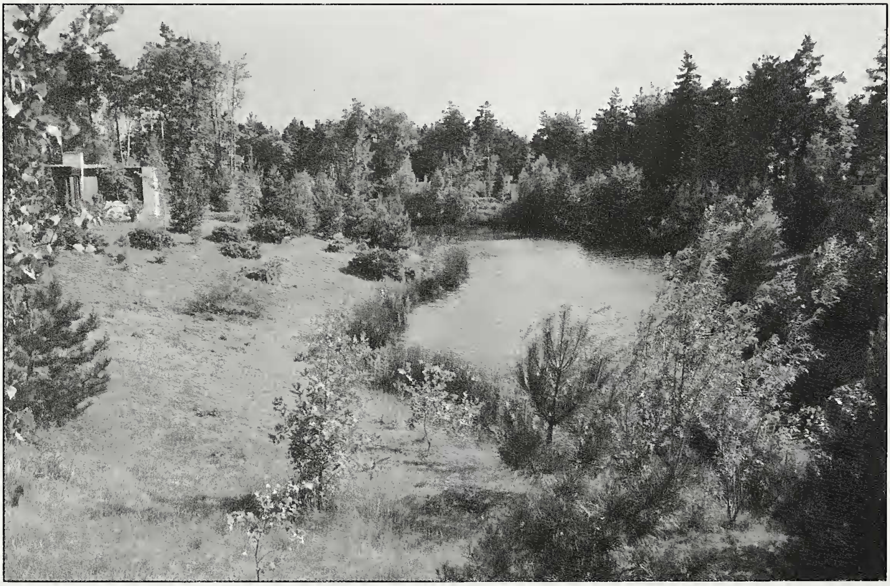

Figure 1. A typical Centerparc residential landscape (Elveden), with villas arranged in clearings containing a pool and informally managed habitats such as grassland and scrub that can support good assemblages of ground-nesting and aerial-nesting aculeates.

The four villages are entirely, or mainly, located within land that was dense coniferous plantation prior to development. The landscaping that has taken place since follows a generally similar pattern featuring the following components:

(i) Coniferous woodland – the dominant habitat, sometimes featuring the original plantation woodland in a dense, unmodified state, but increasingly being thinned to promote a better ground flora.
(ii) Broadleaved woodland – best represented at Sherwood (semi-natural in character), but with some young plantation woodland at Elveden and small patches of secondary woodland at Longleat and Whinfell.
(iii) Villa and plaza landscapes – several hundred villas typically located within thinned coniferous woodland, and each typically arranged with its rear end facing pools or linear water features (except at Whinfell Forest which only has a boating lake); also a central plaza with restaurants and sport facilities. The villas tend to be located within informally managed areas with minimal mowing and naturalistic landscaping, whilst the plaza areas tend to have formal landscaping lacking semi-natural habitat.
(iv) Water features within clearings – includes a main boating lake, which may have some useful surrounding habitat (e.g. Longleat, Elveden, to a lesser extent Sherwood and scarcely at all at Whinfell), plus subsidiary lakes and linear water features running through the villa landscape (except Whinfell). The linear water features are located within larger clearings that typically feature emergent and marginal vegetation grading into grassland, heathland or tall herb, scrub and surrounding woodland. In some cases the grassland has been enhanced by artificial seed mixtures, though at Elveden the seed bank has also produced an impressive natural response involving some very rare native plants such as fingered speedwell *Veronica triphyllos* L. and white horehound *Marrubium vulgare* L.
(v) Wildflower meadows and other discrete grasslands – of varying quality, extent and character. Particularly impressive at Elveden due to the chalky sands that underlie the site, and parts of Longleat (Fig. 2).
(vi) Restored heathland – as all the plantations occur on sandy soils in districts that historically featured heathland, heathers have often established themselves naturally following woodland clearance. But special measures have been taken to promote the heathland at Longleat (Nockatt Coppice Nature Reserve) and Sherwood (compartment 45).
(vii) Car parks – the main car parks (excluding Longleat) feature scrub, fringes of grassland and sparsely-vegetated sand (Fig. 3). These can be very productive.
(viii) Banks, balancing pools and dumping areas – small areas often managed informally and often acquiring a very flowery character after a few years – most notably at Whinfell where such areas provide the only substantial areas of flower-rich habitat within the village.
(ix) Log piles – notably at Elveden and Whinfell, though often temporary in nature (Fig. 4).

The result is four sites that can be best described as ‘diversified coniferous settings’.

Methodology

All the survey work was undertaken on a commercial basis, so the amount undertaken in a given year was dictated by contractual agreement. It typically involved two days worth of surveying of each site in a given year. Occasionally it

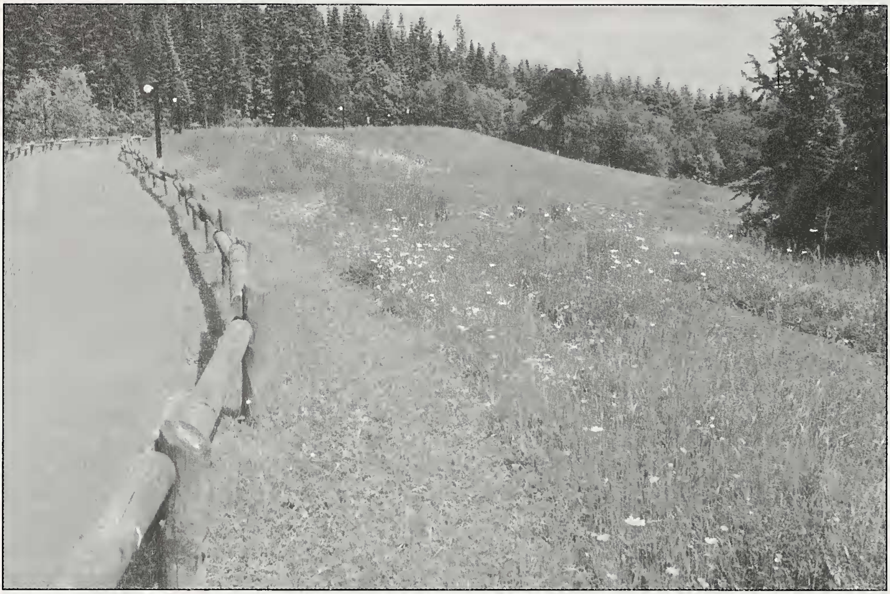

Figure 2. An example of a 'created' wildflower meadow (Longleat). With the right choice of plants and management, these can provide forage areas for many aculeates, especially where plants such as thistles, umbellifers and bird's-foot trefoils are present.

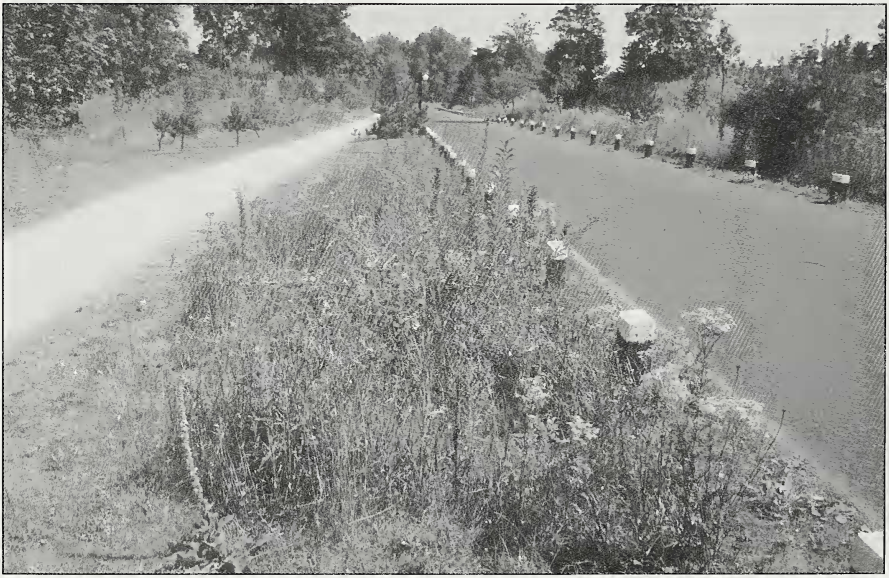

Figure 3. Many areas of a Centerparc village can be managed to encourage wildlife such as aculeates with the right management, including verges, car parks, golf courses and lakesides.

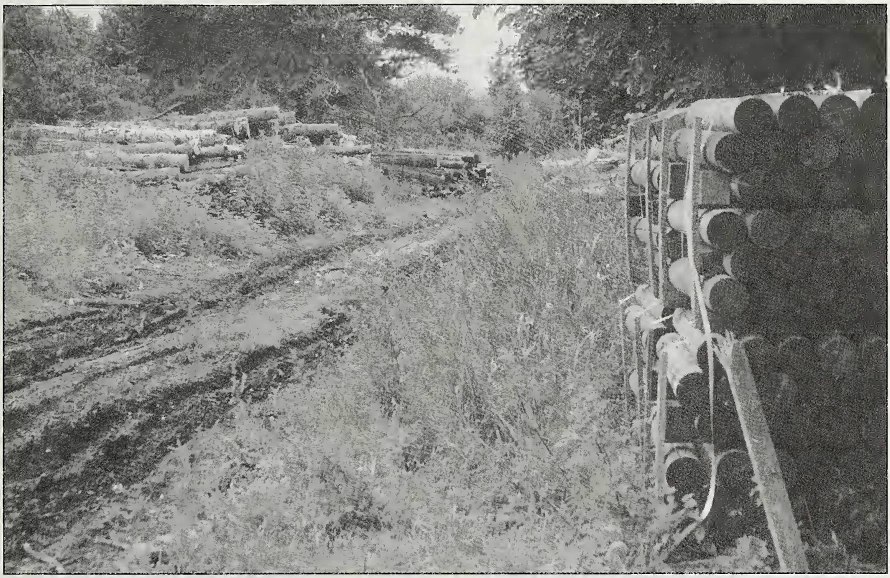

Figure 4. Logpiles at Elveden. These are vital for aerial nesting species and informal dumping and storage areas such as these can be very flowery.

would involve three, but if bad weather was encountered (and much effort was taken to avoid this), only a single day of proper surveying might be possible. Dates of visits were varied from year to year in order to capture data from April to August, and occasionally later. Elveden was surveyed from 1994–2004, Longleat and Sherwood from 1995–2004 and Whinfell Forest (a late addition to the Centerparc portfolio) from 2002–2004. Dates of visits (bracketed dates refer to visits during sub-optimal weather):

- Longleat: 30.iv.95, 12.viii.95, 2.vi.96, (28.vii.96), 19.vii.97, 20.vii.97, (13.vi.98), 5.vii.98, (9.x.99), (10.x.99), 6.vi.00, 8.vi.00, (20.vi.01), 21.vi.01, (1.vii.02), 2.vii.02, 18.vii.03, 19.vii.03, 20.vii.03, 25.vi.04, 27.vi.04.
- Elveden: 23.iv.94, 23.vii.94, 20.v.95, 6.viii.95, 23.vi.96, 17.viii.96, 21.vi.97, 22.vi.97, 11.vii.98, (12.vii.98), 27.v.99, 28.v.99, 24.v.00, (25.v.00), 6.vii.01, (8.vii.01), 17.v.02, 28.vii.02, 16.iv.03, 5.vii.03, 19.vii.04, 7.viii.04.
- Sherwood: (24.vi.95), 30.vii.95, (28.iv.96), 13.vii.96, 30.v.97, 1.vi.97, 29.viii.98, 13.ix.98, 26.vi.99, 18.vii.99, 6.v.00, 7.v.00, 3.vii.01, 4.vii.01, 5.vii.01, 20.v.02, 21.v.02, 13.iv.03, 29.vi.03, 18.vii.04, 21.viii.04.
- Whinfell: (15.vii.02), 16.vii.02, 13.vi.03, 14.vi.03, 15.vi.03, (28.v.04), 30.v.04.

Survey techniques included visual surveillance of foraging and nesting habitats and careful sweeping of different habitats with a long-handled insect net. Areas surveyed included patches of flowers, sparsely vegetated areas, dead wood in sunny locations and sunlit foliage. Special attention was given to the flowers that supported the biggest foraging assemblages at particular times of year, which included (depending on the site):

Spring: grey willow (sallow) *Salix cinerea*, blackthorn *Prunus spinosa*, wild cherry *Prunus avium*, hawthorn *Crataegus monogyna*, common gorse *Ulex europaeus*, dandelions *Taraxacum* spp., daisy *Bellis perennis*, coltsfoot *Tussilago farfara*, cow parsley *Anthriscus sylvestris*, ground-ivy *Glechoma hederacea* and rhododendrons.
Early summer: cat's-ear *Hypochaeris radicata*, mouse-ear hawkweed *Pilosella officinarum*, birds-foot trefoils *Lotus* spp., oxeye daisy *Leucanthemum vulgare*, foxglove *Digitalis purpurea*, bramble *Rubus fruticosus* agg., roses *Rosa* spp. and broom *Sarothamnus scoparius*.
Mid to late summer: thistles (*Cirsium* and *Carduus*), ragworts *Senecio* spp., knapweeds *Centaurea* spp., hogweed *Heracleum sphondylium*, upright hedge parsley *Torilis japonica*, clovers *Trifolium* spp., vetches *Vicia* spp., rosebay willowherb *Chamerion angustifolium*, ling *Calluna vulgaris* and specifically at Elveden: parsnip *Pastinaca sativa*, mulleins *Verbascum* spp., viper's bugloss *Echium vulgare*, field scabious *Knautia arvensis* and mignonettes *Reseda* spp..
Late summer–early autumn: hawkbits *Leontodon* spp., scentless mayweed *Tripleurospermum inodorum* and late flowers from the previous category.

Persistence and timing were very important for producing good lists. Some mining bees, for example, peak very early in the year when the sallow and blackthorn are in blossom. Finding bees with very narrow foraging habits required careful surveillance of specific flowers, including mignonettes for *Hylaeus signatus* (Panzer), field scabious for *Andrena hattorfiana* (F.) and heathers for *Andrena fuscipes* (Kirby) and *Colletes succinctus* (L.). For genera containing species that were indistinguishable in the field, such as *Sphecodes*, *Lasioglossum*, smaller *Andrena*, *Crossocerus*, *Pemphredon* and *Chrysis*, reasonably-sized series were obtained from as many different parts of the site as possible for critical checking under a microscope. A day in the field typically constituted 5–6 hours, including a short lunch break and walks between different compartments.

Three parameters were then used to assess the quality of the assemblages present:

(i) Species richness. This figure was the total number of bee and wasp species recorded per site during the survey period.
(ii) The presence of rare species (Red Data Book and Nationally Scarce species). These were taken from Falk (1991). However, to allow for the fact that some of these gradings are known to be misleading, an asterisk has been placed against the obviously misgraded species in the Appendix and a bracketed re-grade suggestion that is more realistic given afterwards. A rarity score (RS) was evaluated for each site by assigning 100 points to Red Data Book species and 50 points to Nationally Scarce species (following Ball, 1986). Regional scarcity, which can be used in addition to the above grades, could not be assessed easily for these sites due to the lack of county data to hand. The rarity score was divided by the total number of species at a site to produce a species quality index (SQI) which is stated to even out variable recording coverage across multiple sites. These calculations were made for each site following adjustment for obvious misgradings.
(iii) The quality of certain habitat-associated assemblages. A variety of habitat-linked insect assemblages can be used to compare site quality within certain defined parameters. At the sites studied here, these included:

- **Acidophilous species** – species strongly associated with heathland and acid grassland, not simply sandy soils, the presence of which can be used for monitoring the quality of any existing heathland or of any heathland

restoration (species highlighted as '**Acidoph**' in the Appendix). It includes two species specifically requiring heathers for foraging, *Andrena fuscipes* and *Colletes succinctus*.
- **Calcicolous species** – species strongly associated with chalk or limestone habitats (highlighted as '**Calc**' in the Appendix), a useful parameter for assessing and monitoring calcareous habitat in Breckland plantations.
- **Terrestrial snail-associated species** – an insect assemblage that can reflect site quality and includes a number of bees that nest in empty snail shells (highlighted as '**Sn**' in the Appendix). These bees are also calcicoles, though this is not the case with some snail-associated flies and beetles.
- **Aerial nesting solitary species** (excluding cleptoparasites) – to reflect the quantity and variety of dead wood and other opportunities for aerial nesters.
- **Ground-nesting solitary species** (excluding cleptoparasites) to reflect the quantity, quality and variety of ground-nesting conditions.
- **Coastal-biased species** – another useful parameter for Breckland sites which support unusually high concentrations of species most typically associated with coastal dunes (species highlighted as '**Coastal**' in the Appendix).
- **Conifer-associated species** – a useful parameter for some other insect groups (e.g. flies), though only one such species exists within the list – *Passaloecus eremita* Kohl (highlighted as **Conif** in the Appendix).
- **Cleptoparasites** (of both solitary and social species) – which can be converted into a 'cleptoparasitic load' by turning the number of cleptoparasites into a percentage of the total fauna.

RESULTS

Species richness

Large, representative samples of bees and wasps were obtained from all four sites, particularly Elveden, Longleat and Sherwood which were subject to a longer period of study than Whinfell. The data obtained were used to evaluate the quality of the assemblages present at each site. The various scores that underpin this evaluation are presented in Table 1. All the species recorded, and the year(s) are listed in the Appendix, which also furnishes brief notes for the scarcer species, plus any points of interest relating to more frequent ones.

A total of 259 species (excluding *Apis mellifera* L.) was recorded from the four sites, a figure that represents over half of the British bee and wasp fauna and exceeds some county lists. The richest site by far was Elveden, with a total of 203 confirmed species and one unconfirmed one (*Dryudella pinguis* (Dahlbom) – suggested by the presence of its cleptoparasite) based on 11 year's recording. Longleat produced a list of 136 confirmed species plus one unconfirmed one (*Melitta leporina* (Panzer) – suggested by its cleptoparasite) based on ten year's recording. Sherwood produced 124 species based on ten year's recording and Whinfell produced 66 species based on only three year's recording. The Elveden list is one of the best modern site lists in Britain – there are probably only a handful of sites nationally with modern lists exceeding 200 species. Nine species were added to the Elveden list in the final year of recording, suggesting that this list remains incomplete. Elveden also produced two exceptional single day lists of 96 species on 28 July 2002 and 97 species on 19 July 2004. Whilst the lists for the other three sites are somewhat shorter then that for Elveden, they still appear to be very good within their respective counties.

Table 1. Hymenoptera quality scores from the four British Centerparc villages, using a variety of parameters. Rarity scores were adjusted for obvious misgradings of species (see Appendix).

	Longleat	Elveden	Sherwood	Whinfell
Confirmed species (unconfirmed)	136 (137)	203(204)	124	66
Nationally Endangered (RDB1)	0	0	0	0
Nationally Vulnerable (RDB2)	0	2	0	0
Nationally Rare (RDB3)	2	6	0	0
Nationally Scarce (N)	8	34	6	3
Rarity Score (based on RDB & N spp)	600	2500	300	150
Species Quality Index	4.41	12.32	2.42	2.28
Aerial-nesting solitary species (%)	29 (21.3)	49 (24.1)	29 (22.6)	12 (18.2)
Ground-nesting solitary Species	42	69	55	17
Calcicolous species	3	6	0	0
Snail-nesting species	2	2	0	0
Acidophiles	6	6	10	6
Coastal-biased species	0	7	0	0
Conifer-associated species	0	0	1	0
Cleptoparasites (load)	30 (22.1)	45 (22.2)	26 (20.1)	19 (28.8)

The presence of rare and scarce species

Some very significant records were obtained, including several species additional to the recently published list for Cumbria (Robertson, 2005). These scarcer species are highlighted in the Appendix. All sites produced records of rare or scarce species, though the number of these and the resultant SQI value varied greatly (see Table 1). Elveden produced a rarity score of 2500 derived from the presence of eight Red Data Book species and 34 Nationally Scarce ones. Longleat scored 600 due to the presence of two Red Data Book species and eight Nationally Scarce ones. Sherwood scored 300 due to the presence of six Nationally Scarce species and the under-recorded Whinfell scored 150 due to the presence of three Nationally Scarce species. Converting the scores to a species quality index gave the same ranking, though this calculation has been found by the author to create quite distorted impressions of relative site quality on a number of occasions. In this study, the SQI values suggested that Sherwood and Whinfell were of similar quality. But this is quite unlikely given the northern location and less sandy nature of Whinfell and would probably be confirmed with more surveying of Whinfell.

The quality of some key species assemblages

Seventy-one aerial nesters (excluding cleptoparasites), seven calcicoles, two snail-users, 15 acidophiles and seven coastal-biased species were recorded. The numbers of these found at each site are summarised in Table 1. Elveden had the highest number of aerial nesters (49) and the highest proportion of aerial nesters within its fauna, though the latter figure was only slightly greater than the figures for Sherwood and Elveden. Elveden also had the greatest number of calcicoles (6) with Longleat being the only other site capable of supporting any (3). Both sites supported two snail-users, which are both strongly calcicolous (*Osmia bicolor* (Schrank) and *Hoplitis spinulosa* (Kirby)). Only Elveden was capable of supporting any coastal-biased species, an assemblage of seven. Sherwood produced the highest number of acidophilous species (10), with the other three sites each supporting six. Sherwood was the only site found to be supporting the conifer-requiring *Passaloecus eremita*. The number of cleptoparasites was greatest at Elveden, though as a proportion of the total aculeate fauna, the 'load' was not significantly greater than that for either Longleat or Sherwood. By comparison, the meagre fauna of 19 cleptoparasites at Whinfell actually constituted a load of nearly 30% of the entire fauna, a value much higher than the other three sites.

Discussion

The rarity scores for Elveden, Longleat and Sherwood indicate that they should be considered important sites for aculeate Hymenoptera. Rarity scores for some other key sites recently subject to comparable surveys, based on modern lists of Red Data Book and Nationally Scarce species, include 1200 for Highgate Common, Staffordshire (a heathland supporting the richest bee and wasp fauna currently known in the West Midlands) and 650 for the Bishops Hill-Bishops Bowl complex, Warwickshire (a limestone site supporting the second richest bee and wasp fauna currently known in the West Midlands) (Falk, 2006). The rarity score for Elveden should be viewed as reflecting a bee and wasp assemblage of national significance.

Factors influencing species richness

A number of factors appeared to influence the different species richness of the four sites:

(i) **The extent and quality of floristically diverse habitat.** Elveden currently supports considerably more semi-natural grassland than the other three Centerparcs. What is more, this grassland has formed on calcareous chalky sands and has a character resembling that of other classic Breckland sites such as Wangford Warren, Red Lodge and East Wretham Common. These grasslands are characterised by very rich floras containing both calcicoles and typical heathland plants and with high densities of flowers throughout summer months that attract a rich fauna. The abundance of umbellifers such as hogweed and parsnip was found to be critical. Parsnip, in particular, plays an important role as a forage plant for bees and wasps at Breckland sites, and it was largely the persistent surveying of some very large stands at Elveden that produced the two exceptional single day lists noted above. Hogweed was present at parts of Whinfell and was of major importance there, but Longleat and Sherwood supported very few umbellifers, which almost certainly reduced the potential of these sites for bees and wasps. As a rule of thumb, acidic soils tend to be less floristically diverse and produce a less continuous sequence of useful flowers compared with calcareous sites, though the heather flowers that can be present in late summer are very important. Spring blossoming shrubs such as *Salix*, *Prunus* and *Ulex* are very important in March and April for *Andrena* and *Nomada* bees. But whilst these shrubs occurred widely at Elveden and Sherwood, they were scarce at Longleat and Whinfell, which was reflected in their much smaller spring bee faunas. But aside from the variety of flowers present, the sheer extent of open habitat within these coniferous settings was probably crucial as many bee and wasp species cannot survive in small patches of otherwise suitable habitat. This is borne out by the author's work at various Warwickshire plantations that are not diversified or only slightly so. Simple ride systems and small clearings tend not to support rich aculeate faunas (e.g.

Hay Wood SP2071 and Birchley Hays Wood SP2684), but the fauna will increase where wider rides are created and larger, more permanent patches of grassland are present (e.g. Brandon Wood SP3876 and Oversley Wood SP1056).

(ii) **Geographic location.** Most bees and wasps have a southern bias (often a south-eastern bias), which means that one tends to find smaller assemblages of aculeates further north. It is not a strict rule, as many other variables can affect the fauna of a site and result in some relatively rich sites in the north and poor sites in the south. The best sites in the Brecks and southern heathland districts support over 200 species, whilst the best ones in the Midlands support about 130 species (S. Falk data) and few sites in northern England have lists exceeding 100 species (M. Archer data). The influence of geographical location is clearly reflected in the Centerparc data, even if the more calcareous nature of Elveden and the under-recording of Whinfell are allowed for. But it should be noted that Whinfell supported three northern-biased species (*Bombus monticola* Smith, *Crossocerus leucostomus* (L.) and *Passaloecus monilicornis* Dahlbom) that would not be anticipated from the other three sites.

(iii) **The surrounding countryside.** All four Centerparcs were located within much larger tracts of conifer plantation and other habitats of varying ecological character and quality. Elveden was most fortunate in its location, lying adjacent to the 570 ha Lakenheath Warren SSSI, with Wangford Warren and several other important chalk-heath sites within a few miles. This almost certainly facilitated the colonisation of new habitats created at this Centerparc over the past 15 years and allowed colonisation by some surprisingly scarce species. It is best to view Breckland bee and wasp assemblages as being comprised of numerous local populations (metapopulations) that can move around the Breckland landscape with different levels of efficiency, taking advantage of any new suitable habitat that forms reasonably close to an existing colony of a given species. This would help to explain why species such as *Andrena hattorfiana* and *Melitta haemorrhoidalis* (F.) were recorded at Elveden, even though only small quantities of their forage plants were present (less than would be needed for viable, permanent populations). It is possibly also the reason why so many species were only recorded once despite careful surveying over many years. Longleat is located within an area that lost much of its former heathland through coniferisation. The new heathland created is currently very isolated, and the bee and wasp fauna it supports is unexceptional in a southern England context, presumably because there are few nearby sources for such species. The heathland here notably lacked the two heather specialist bees found at Sherwood and Elveden, sites which both occur within districts characterised by much heathland. Sherwood's location within a district supporting particularly extensive areas of lowland heathland may explain why its new heathland supported the highest number of acidophiles, including two heather–associated bees, and why more ground nesting solitary species were present than Longleat (55 vs. 42).

(iv) **The availability of dead wood and other aerial nesting opportunities.** Whilst the majority of bees and wasps present were ground-nesters, aerial nesters still comprised a significant proportion of the fauna. The number of aerial nesting species was partially dictated by the quantity and variety of dead wood and hollow stems, though the previous three factors also exerted strong influences. The high number of aerial nesters at Elveden in part reflected the greater amount of dead wood (both large log piles and some standing dead trees), key shrubs such as elder *Sambucus nigra*, bramble and roses (which produce hollow twigs), and herbs such as umbellifers and thistles (good at producing hollow stems).

Factors affecting the presence of rare and scarce species

The main factors influencing the presence of so many scarce species at Elveden were probably much the same as those influencing its greater species richness. The majority of rare and scarce species have southern biases, which explains the greater number of such species at Longleat than Sherwood, despite the similar length of their species lists.

Factors affecting the quality of some key species assemblages

Underlying geology and site history were particularly important for the presence of calcicoles and acidophiles. The chalky soils of Elveden produced calcareous vegetation in many places supporting good stands of calcicolous plants such as wild parsnip, mignonettes, viper's bugloss and field scabious, and attracting six aculeate species typically associated with chalk and limestone. A small balancing pool at Longleat was the only other calcareous habitat found within the four villages, but its limited size and isolation from other calcareous habitat meant it could only support three calcicoles. For acidophiles, the area and quality of heather-rich vegetation or acid grassland were very important, and the scores more or less mirror this, with Sherwood supporting the most. The presence of coastal-biased species was completely restricted to Elveden, and such species have a high proportion of their inland populations within the Breckland. This may be linked to the particularly loose sands associated with many parts of the Brecks and possibly also the historical presence of mobile dunes here, for example at Wangford Warren. Descriptions from the late 17th century liken parts of the Breckland region to the deserts of Libya with sand sometimes engulfing the village of Santon Downham to a depth of at least 2.75 m (Wright, 1668). The cleptoparasitc load value is sometimes portrayed as a quality indicator. However, the results from this study suggest it is not reliable, as the load was highest for the least interesting site judged on most other parameters (Whinfell) and that for the exceptional Elveden was not significantly higher than Longleat or Sherwood.

Encouraging bee and wasp richness in coniferous plantations

One of the broader objectives of the study was to propose land management options that could increase aculeate biodiversity. The following is a simple checklist of techniques that can be considered when attempting to promote bee and wasps assemblages in coniferised settings, based on the author's experiences at the four Centerparcs and plantations in Warwickshire.

1. Maximise the amount of grassland and heathland in and around plantations

- Scallop rides and manage rotationally to diversify conditions – vary the orientation of such rides where possible, remembering that sunny, south-facing edges are more valuable for bees and wasps than shaded north-facing ones.
- Create blocks of permanent grassland and manage to enhance floristic diversity, using natural regeneration where sufficient, but consider carefully sourced seed mixtures where not.

- Create blocks of heathland where soils are suitable and manage to promote heathers and areas of bare, sandy ground. Former conifer plantation can support good heathland regeneration if excess litter and brash are removed (Walker *et. al.*, 2004; pers. obs.).
- Control scrub encroachment (gorse scrub is particularly invasive at Sherwood and Elveden).
- Manage grasslands using a variety of regimes to create varied conditions and to find which approaches produce the best responses. Consider occasional scarifying to break up coarse grassland and promote disturbance-loving plants. Some areas of grassland at the Centerparcs have lost diversity as they have matured, but scarifying has produced very good results at Elveden.

2. Promote dead wood and aerial nesting opportunities

- Create log piles in sunny locations, preferably in different parts of the site.
- Encourage some standing dead timber such as dead trees or stumps (including up-turned root plates with their bases facing the sun).
- For stem nesters, encourage key shrubs such roses, elder, bramble, also stands of herbaceous plants such as umbellifers and thistles.

3. Promote key forage plants

- Blossoming shrubs and trees such as cherries, blackthorn and other *Prunus* spp., willows, crab apple, hawthorns, elder, *Viburnum* spp. and maples can be valuable forage plants. Introduce if necessary.
- Umbellifers, especially hogweed, cow parsley, hedge parsley and (at Breckland sites) wild parsnip. Areas with richer soils, such as places used for dumping and outside storage (including top-soil storage), around log piles, around car parks etc. can be particularly suitable for hogweed and cow parsley.
- Heathers – very important in late summer.
- A good variety of composites, legumes, labiates, mignonettes and flowers listed earlier in this paper, as appropriate to a site.

4. Others

- Thin existing woodland to encourage a ground flora – which may promote useful forage plants such as bramble, bilberry and foxglove.
- Produce topographic features – such as south-facing banks and slopes, pits and trenches, especially where the ground is sandy and in sunny, sheltered locations. Avoid top-soiling such locations.
- Embrace the role of rabbits, moles and human trampling – all of which can enhance open habitats for bees and wasps by promoting nesting areas and disturbance-loving flowers. Even well-trodden paths can support good nesting colonies, but avoid placing artificial surfaces on paths if unnecessary.

Kirby (1992) furnishes a more detailed account of woodland management for invertebrates, including the management of rides and clearings, promotion of dead wood habitats, and importance of trees and shrubs. The above list can also be applied to broadleaved plantations e.g. blocks of poplars, and to semi-natural broadleaved woodland.

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References

Anon. 1998. *England Forestry Strategy – A New Focus for England's Woodlands*. Forestry Commission (England).

Archer, M.E. 1987. The Wasps and Bees (Hymenoptera: Aculeata) of the Breckland and Suffolk Sandlings: the first 28 visits. *Contract Surveys*, **8**. Nature Conservancy Council, Peterborough.

Archer, M.E. 1996. The aculeate wasps and bees (Hym., Aculeata) of Sherwood Forest in Nottinghamshire and the development of a national quality assessment scheme. *Entomologist's Monthly Magazine*, **132**: 35–44.

Falk, S.J. 1991. A review of the scarce and threatened bees, wasps and ants of Great Britain. *Research and Survey in Nature Conservation* 35. Nature Conservancy Council, Peterborough.

Falk, S.J. (2006) The modern bee and wasp assemblages (Hymenoptera: Aculeata) of Warwickshire's calcareous quarries and spoilheaps, and the conservation issues facing them. *British Journal of Entomology and Natural History*, **19**: 7–33.

Kirby, P. 1992. *Habitat Management for invertebrates: a practical handbook*. Royal Society for the Protection of Birds, Sandy.

Robinson, N.A. 2005. A list of the bees, wasps and ants of Cumbria. Records to the year 2005. *BWARS Newsletter*, Autumn 2005.

UK Biodiversity Steering Group, 1995. *Biodiversity: the UK Steering Group Report. Action Plans*. HMSO, London.

UK Government, 1994. *Biodiversity: The UK Action Plan*. HMSO, London

Walker, K.J., Pywell, R.F., Warman, E.A., Fowbert, J.A., Bhogal, A. & Chambers, B.J. 2004. The importance of former land use in determining successful re-creation of lowland heathland in southern England. *Biological Conservation*, **116**: 289–303.

Wright, T, 1668. A curious and exact relation of a Sandfloud. *Philosophical Transactions of the Royal Society of London*, **3**: 722–725.

Appendix. The species recorded with notes

The following list includes the Centerparc at which each species was recorded (LONG – Longleat, ELV – Elveden, SHERW – Sherwood, WHINF – Whinfell) and the year of the record(s) i.e. 96 = 1996, 03 = 2003. The number of years gives some indication of the success with which a species can exploit diversified coniferous settings. Some full dates are given for very important records. Other abbreviations include: **RDB1, 2** or **3** plus **N** – the rarity grading, **Acidoph** – a species strongly associated with heathland and acid grassland, **BAP** – a Biodiversity Action Plan Priority Species (UK Biodiversity Steering Group, 1995), **Calc** – a strongly calcicolous species, **Coastal** – a species strongly associated with coastal dunes, and **Conif** – a species strongly associated with conifers. A rarity value expressed **RDB3* (N)** means it is a species currently graded as RDB3 that requires downgrading to Notable in the opinion of the author. Notes have been provided to indicate some of the key requirements of the individual species within such settings, particularly the scarcer ones.

Chrysididae

Chrysidid wasps are mostly parasitoids of the larvae of crabronid and non-social vespid wasps (*Cleptes* excepted) with individual species usually associated with either ground-nesting hosts or aerial nesting hosts.

Chrysis angustula Schenck LONG: 04, ELV: 97, 02, 03. *Chrysis* wasps mostly attack vespid and crabronid wasps. Dead tree trunks, stumps and log piles are important for the hosts of all the species listed except *C. illigeri* (Wesmael).

C. ignita (L.) ELV: 94.

C. illigeri (Wesmael) N LONG: 98, ELV: 96, 97, 98. Attacks the ground-nesting *Tachysphex pompiliformis*. Good numbers recorded on sandy calcareous grassland at Elveden in some years.

C. impressa Schenck ELV: 96, 97, WHINF: 03 (seemingly a new county record).

C. mediata Linsenmaier ELV: 99.

C. ruddii Schuckard WHINF: 02 (seemingly a new county record).

Cleptes nitidulus (F.) N ELV: 96. *Cleptes* species are parasites of sawfly larvae.

C. semiauratus (L.) N* **(no status)** LONG: 98, ELV: 97, SHERW: 95, 96, 99. Mostly swept from sallow carr and shaded undergrowth.

Elampus panzeri (F.) **Acidoph** LONG: 97, ELV: 94, 95, 96, 97, 98, 01, 02, 03, 04, SHERW: 99, 01, WHINF: 02 (seemingly a new county record). Attacks the ground-nesting *Mimesa equestris* (F.). Particularly abundant at Elveden on sandy calcareous grassland.

Hedychridium ardens (Latreille *in* Coquebert) LONG: 97, ELV: 96, 98, SHERW: 97. Attacks *Tachysphex pompiliformis* (Panzer) which nests in sandy ground.

H. cupreum (Dahlbom) N ELV: 94. The host wasp *Dryudella pinguis* was not actually recorded at Elveden but can be easily overlooked. Sandy ground is required.

H. roseum (Rossi) **no status* (N) Acidoph** ELV: 04. Requires sandy ground with plentiful *Astata* and *Tachysphex* wasps.

Hedychrum niemelai Linsenmaier **RDB3** ELV: 02, 03, 04. Requires sandy grounds with plentiful *Cerceris* wasps.

Omalus puncticollis (Mocsáry) N LONG: 04, ELV: 04. Associated with stem or dead wood-nesting crabronid wasps.

Trichrysis cyanea (L.) LONG: 95, 97, 01, ELV: 94, 96, 01, 02, 04, SHERW: 96, WHINF: 03 (seemingly a new county record). Requires good populations of *Trypoxylon* wasps, though possibly uses other aculeates such as *Hylaeus* bees (M. Edwards, pers. comm.) and particularly associated with root plates of felled conifers at Longleat; also log piles at some of the other sites.

TIPHIIDAE

Tiphia femorata F. ELV: 94, 95, 96, 02, 04. Requires sandy ground and an input of dung (the larvae are presumed predators of dung beetle larvae). The Elveden population was very strong in some years, but seemed to crash in others.

T. minuta Vander Linden N* **(no status)** LONG: 01, ELV: 96, 99, SHERW: 01, WHINF: 02, 03. Possibly associated with rabbit dung (its larvae possibly attacking the beetle larvae associated with such dung).

MUTILLIDAE

Myrmosa atra Panzer LONG: 96, 97, 98, 03, 04, ELV: 94, 96, 97, 98, 01, 02, 03, 04, SHERW: 96, 99, 01, 03, 04, WHINF: 02. Associated with ground-nesting bees and wasps in open habitats with bare or sparsely-vegetated light soils.

POMPILIDAE

Most of the pompilids listed here require sparsely-vegetated ground fully exposed to the sun (especially sand or dry earth on south-facing slopes supporting plentiful prey spiders) except *Dipogon subintermedius* which is associated with dead wood and trees.

Anoplius infuscatus (Vander Linden) ELV: 99.
A. nigerrimus (Scopoli) LONG: 97, 98, 00, SHERW: 99.
A. viaticus (L.) LONG: 97, ELV: 94, 95, 96, 98, 00, 02, 03, 04, SHERW: 95.
Arachnospila anceps (Wesmael) LONG: 97, 98, ELV: 95, 96, 97, 99, 02, 03, 04, SHERW: 95, 00, 01, 02, 03, 04, WHINF: 03.
A. minutula (Dahlbom) **N Calc** ELV: 98, 99.
A. spissa (Schiødte) LONG: 01, ELV: 96, 97, 99, 00, SHERW: 96, 97, 99, WHINF: 03, 04.
A. trivialis (Dahlbom) ELV: 95, 96, 04.
A. wesmaeli (Thomson) **N** ELV: 96, 04.
Caliadurgus fasciatellus (Spinola) LONG: 97.
Dipogon subintermedius (Magretti) ELV: 95.
Episyron rufipes (L.) ELV: 94, 95, 96, 97, 98, 01, 04.
Evagetes crassicornis (Schuckard) ELV: 94, 95, 96, 98, 99, 02, 04, SHERW: 01, WHINF: 03, 04. *Evagetes* species are cleptoparasites of other pompilids and their presence tends to indicate good conditions are present for pompilids.
E. dubius (Vander Linden) **N** ELV: 96, 98.
Priocnemis coriacea Dahlbom ELV: 94.
P. gracilis Haupt **N** ELV: 96.
P. hyalinata (F.) **N** ELV: 01, 02.
P. perturbator (Harris) LONG: 96, ELV: 94, 96, 02, SHERW: 97, 00, 02, WHINF: 03.
P. pusilla Schiødte ELV: 96, 04.
P. schiodtei Haupt **N Acidoph** SHERW: 95, 99, 03. At this and other Midlands localities, this pompilid showed a strong association with a *Calluna*, acid grassland and bare sand mosaic, though it is uncertain if it shows this habitat fidelity in other regions.
P. susterai Haupt LONG: 01, ELV: 99, 00, 02, SHERW: 00.

VESPIDAE

The non-social vespids *Ancistrocerus*, *Gymnomerus*, *Microdynerus* and *Symmorphus* are aerial nesters that rely variously on dead wood and hollow stems. The social wasps typically form nests either within foliage (*Dolichovespula*) or within cavities (*Vespa* and *Vespula*) and produced some particularly good assemblages at Elveden, Longleat and Sherwood.

Ancistrocerus gazella (Panzer) LONG: 98, ELV: 03, SHERW: 95. *Ancistrocerus* species are particularly dependent upon hollow stems of plants like *Rubus* and elder and also the cavities associated with dead wood and old trees. Log piles often attract several species.
A. nigricornis (Curtis) ELV: 94, 95, 96, 02, 04.
A. oviventris (Wesmael) LONG: 97, 04, ELV: 96.
A. parietinus (L.) ELV: 04, SHERW: 97.
A. parietum (L.) LONG: 95, SHERW: 96, 99.
A. scoticus (Curtis) WHINF: 04.
A. trifaciatus (Müller) LONG: 01, ELV: 96, 97, 99, 04, SHERW: 95, 96, 97, 01, 02, WHINF: 03
Dolichovespula media (Retzius) **N* (no status)** LONG: 03, ELV: 94, 95, 02, 03, 04, SHERW: 95, 04. Often numerous at Elveden, the males liking *Pastinaca* flowers in particular.

D. norwegica (F.) LONG: 98, SHERW: 95, WHINF: 02, 03, 04. Frequent at the last site, reflecting a northern bias.

D. saxonica (F.) **RDBK* (no status)** LONG: 00, 01, 03, 04, ELV: 94, 95, 98, 99, 02, 03, 04, SHERW: 04. This recent colonist clearly thrives in these settings and has been seen in good numbers at the three listed sites in certain years – the males usually congregating on umbellifer flowers.

D. sylvestris (Scopoli) LONG: 95, 03, 04, ELV: 94, 95, 98, 03, 04, SHERW: 95, 96, 98, 00, 01, 03, 04, WHINF: 02.

Gymnomerus laevipes (Shuckard) LONG: 97, 98, 00, 01. Dependent upon hollow stems of plants such as *Rubus*, *Arctium*, *Sambucus* and thistles.

Microdynerus exilis (Herrich-Schäffer) **N** ELV: 02. Typically nests in old beetle holes in dead wood including fence posts, but sometimes in the ground (M. Edwards, pers. comm.).

Symmorphus bifasciatus (L.) ELV: 94, 95, 03, 04, SHERW: 95. The nesting habits of *Symmorphus* species resemble *Ancistrocerus*.

S. gracilis (Brullé) ELV: 94, 96, 97, 98, 01, SHERW: 01.

Vespa crabro L. LONG: 99, 00, 04, ELV: 95, 99, 02.

Vespula germanica (F.) SHERW: 04. The lack of records for this generally common species is noteworthy.

V. rufa (L.) LONG: 95, 96, 97, 98, 00, 01, 02, 04, ELV: 94, 95, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 00, 03, WHINF: 03. Particularly favoured tall grasslands and heathland at these sites, though no sign of its cleptoparasite *V. austriaca* (Panzer) at Whinfell, which would have been expected at such a northern location.

V. vulgaris (L.) LONG: 95, 96, 97, 99, 00, 01, 02, 04, ELV: 94, 95, 96, 97, 98, 00, 02, 03, 04, SHERW: 95, 97, 98, 00, 02, 03, 04. Utilised a wide range of habitats including the lodges and more heavily developed parts of the site.

Sphecidae

Sphecid wasps require bare and sparsely-vegetated sandy ground for nesting and stock their cells with caterpillars obtained from nearby vegetation.

Ammophila sabulosa (L.) LONG: 95, ELV: 94, 95, 96, 97, 98, 99, 02, 03, 04, SHERW: 95, 96, 97, 99, 01. Requires a mosaic of bare, sandy ground together with patches of grassland and/or heather. The Longleat record is significant in a Wiltshire context.

Podalonia affinis (Kirby) **RDB3* (N) Coastal** ELV: 96. Requires sparsely-vegetated sandy ground with most records for coastal dunes plus the Brecks.

Crabronidae

A requirement for sparsely-vegetated sandy ground features in many of these solitary wasps, whilst a smaller but still sizeable assemblage nest in dead wood (including log piles) or hollow plant stems. Hunting occurs in the surrounding vegetation including grassland, shrub and tree foliage and on flowers, depending on the species involved, with prey ranging from aphids and tiny spiders through to grasshoppers, beetles, flies and other aculeates, depending on the species.

Argogorytes mystaceus (L.) LONG: 00, 01, 02, 04, SHERW: 99, 01, 03, WHINF: 03, 04. Requires areas of longer grass with plentiful cuckoo-spit (it stocks its cells with the nymphs contained within), perhaps especially at woodland edge.

Astata boops (Schrank) LONG: 97, 01, ELV: 98, 01, 02, 04. Likes sparsely-vegetated ground, including sands and dry clays.

Cerceris arenaria (L.) LONG: 96, 03, ELV: 94, 95, 96, 97, 98, 01, 02, 03, 04. Most *Cerceris* species require sandy ground, such as well-trodden (but not churned) footpaths for nesting. A very strong population of *C. arenaria* occurred at Elveden with some very large nesting aggregations.

C. quinquefasciata (Rossi) **RDB3 BAP** ELV: 94, 95, 96, 98, 01, 02, 03, 04. Elveden supported a very strong population of this rare species, which forages and hunts on umbellifers such as *Torilis* and *Pastinaca*.

C. ruficornis (F.) **No status* (N)** ELV: 03, 04. Seemingly absent at Elveden when the study started, but found in reasonable numbers in the final two years.

C. rybyensis (L.) LONG: 97, 98, 01, 03, 04, ELV: 94, 96, 97, 98, 01, 02, 03, 04. This species can also utilise non-sandy sites with dry clays.

Crabro cribrarius (L.) ELV: 94, 95, 96, 97, 01, 02, 03, 04, SHERW: 95, 96.

C. peltarius (Schreber) ELV: 94, 96, 97, 99, 00, 02, 04, SHERW: 96, 99, 01, 03, 04.

Crossocerus annulipes Lepeletier & Brullé ELV: 94, 95, 96.

C. capitosus (Schuckard) ELV: 96.

C. cetratus (Schuckard) LONG: 01, ELV: 95, 96, 00, 03, SHERW: 02, 03, WHINF: 04. This species particularly favours log piles for nesting.

C. dimidiatus (F.) ELV: 96.

C. distinguendus (A. Morawitz) **N** ELV: 04. Its late discovery at Elveden corresponds with a marked expansion of its range nationally in recent years. The complete lack of records for the closely-related and widespread *C. elongatulus* (Vander Linden) is noteworthy.

C. leucostomus (L.) **N** WHINF: 02, 03, 04. A northern species with a strong colony at Whinfell associated with a large log pile.

C. megacephalus (Rossi) LONG: 01, 95, ELV: 96, 99, 03, SHERW: 97, WHINF: 02.

C. nigritus Lepeletier & Brullé ELV: 02, 04.

C. ovalis Lepeletier & Brullé LONG: 97, ELV: 02, 04, SHERW: 01, 04, WHINF: 03. Needs sparsely-vegetated ground, typically on sand and dry clays.

C. palmipes (L.) **N** ELV: 01, 02, 03.

C. podagricus (Vander Linden) LONG: 97, ELV: 94, 96, 97, 01, 02, 03, 04, SHERW: 97, 99.

C. pusillus Lepeletier & Brullé LONG: 97, 03, ELV: 99, 01, 03, SHERW: 98, 99, WHINF: 03.

C. quadrimaculatus (F.) LONG: 97, 98, 01, 03, ELV: 96, 04, SHERW: 98, 03, 04. Requires particularly sandy areas.

C. styrius (Kohl) SHERW: 97.

C. wesmaeli (Vander Linden) ELV: 94, 95, 96, 01, 02, 04.

Diodontus luperus Schuckard LONG: 97. *Diodontus* species require sparsely-vegetated sandy ground or dry clays for nesting.

D. minutus (F.) ELV: 96, 97, 98, 01, 02, 03, 04.

D. tristis (Vander Linden) ELV: 99.

(*Dryudella pinguis* (Dahlbom) ELV: presence suggested by recording of its chrysidid parasite *Hedychridium cupreum*)

Ectemnius cavifrons (Thomson) LONG: 03, ELV: 94, 95, 96, 97, 01, 02, 04, SHERW: 97, 04, WHINF: 02, 03. *Ectemnius* species require dead wood such as old stumps and log piles for nesting and hunt Diptera from foliage and flowers (especially umbellifers).

E. cephalotes (Olivier) ELV: 95, 02, 04.

E. continuus (F.) LONG: 95, 98, 01, 03, ELV: 94, 96, 00, 03, 04, WHINF: 04.

E. lituratus (Panzer) LONG: 03, ELV: 02, 04. The data for these two sites plus other locations studied by the author suggests this species is currently expanding in southern Britain.

E. ruficornis (Zetterstedt) **N** ELV: 04. This and the next species were abundant on *Pastinaca* and *Heracleum* flowers in the final year of the study.

E. sexcinctus (F.) **N** ELV: 04.

Entomognathus brevis (Vander Linden) LONG: 03, 04, ELV: 94, 96, 98, 01, 02, 03, 04, SHERW: 01. Requires sparsely-vegetated ground on light soils.

Gorytes laticinctus (Lepeletier) **RDB3** LONG: 19.vii.97. A very significant record – one of very few for Wiltshire. Recorded from a gravelly depression with invading scrub and bramble.

Harpactus tumidus (Panzer) LONG: 97, 01, ELV: 94, 95, 96, 98, 02, 03, 04, SHERW: 99, 01, WHINF: 02, 03. Requires sparsely-vegetated ground on light soils.

Lindenius albilabris (F.) LONG: 97, 01, 02, 03, 04, ELV: 94, 96, 01, 03, 04, SHERW: 95, 96, 99, 01, 03. Requires sparsely-vegetated ground on light soils.

Mellinus arvensis (L.) ELV: 95, SHERW: 98, 04, WHINF: 02. Requires sparsely-vegetated ground on light soils.

Mimesa bicolor (Jurine) **RDB2** ELV: 6.vii.03. *Mimesa* species require sparsely vegetated ground on light soils. This is a highly significant record.

M. equestris (F.) **Acidoph** LONG: 97, 98, 01, 02, 03, 04, ELV: 94, 95, 96, 98, 01, 02, 03, 04, SHERW: 95, 96, 99, 01, WHINF: 02.

Mimumesa dahlbomi (Wesmael) LONG: 95, 97, 01, ELV: 95, 96, 00, 01, 03, SHERW: 01. Nests in dead wood including log piles.

Nysson dimidiatus Jurine **N** LONG: 97, 01, ELV: 94, 95, 96, 98, 01, 02, 03, 04, WHINF: 02 (seemingly a new county record). The parasite of *Harpactus tumidus*.

N. spinosus (Forster) LONG: 00, SHERW: 97, WHINF: 03. The parasite of *Argogorytes mystaceus*.

Oxybelus argentatus Curtis **N Coastal** ELV: 03. *Oxybelus* species require particularly loose sand in hot locations. *O. argentatus* and *O. mandibularis* are particularly characteristic of coastal dunes but have significant strongholds in the Brecks.

O. mandibularis Dahlbom **N Coastal** ELV: 03.

O. uniglumis (L.) LONG: 95, 97, 98, 01, ELV: 94, 95, 96, 97, 98, 99, 01, 02, 04, SHERW: 95, 96, 99, 01, WHINF: 02, 04.

Passaloecus corniger Shuckard SHERW: 96, 97. *Passaloecus* species are particularly dependent on old beetle burrows in dead wood (though some species use hollow stems) and benefit from log piles and old tree stumps.

P. eremita (Kohl) **Conif** SHERW: 99, 03. This species shows a strong attachment to beetle holes in pine trunks and hunts pine aphids (M. Edwards, pers. comm.).

P. gracilis (Curtis) ELV: 94, 95, 96, 01, 02, 04, SHERW: 96, 01.

P. insignis (Vander Linden) SHERW: 99.

P. monilicornis (Dahlbom) WHINF: 02.

P. singularis Dahlbom LONG: 04, ELV: 01, 02.

Pemphredon inornata Say LONG: 95, 01, 02, ELV: 96, 01, SHERW: 96, 98, WHINF: 03. *Pemphredon* nest in dead wood such as log piles and tree stumps, also hollow stems.

P. lethifera (Schuckard) ELV: 95, 04, SHERW: 95, 01.

P. lugubris (F.) ELV: 95, 02.

P. morio Vander Linden **N** LONG: 97.

Psenulus concolor (Dahlbom) ELV: 96. *Psenulus* sp. nest in dead wood or hollow stems.

P. pallipes (Panzer) LONG: 01.

Rhopalum clavipes (L.) LONG: 04, ELV: 99, SHERW: 99. *Rhopalum* wasps nest in hollow stems and dead wood.

R. coarctatum (Scopoli) ELV: 01, SHERW: 96, 01.

Spilomena curruca (Dahlbom) LONG: 01, 02. *Spilomena* wasps nest in hollow stems and dead wood.

S. troglodytes (Vander Linden) ELV: 95.

Stigmus pendulus Panzer **RDBK* (N)** SHERW: 03. *Stigmus* wasps nest in hollow stems and dead wood.

S. solskyii Morawitz, A. LONG: 03, ELV: 94, 03.

Tachysphex pompiliformis LONG: 97, ELV: 96, 97, 98, 99, 02, 04, SHERW: 97, WHINF: 02, 03. Requires sparsely-vegetated, sandy areas with plentiful grasshoppers. Supports several scarce cleptoparasitic aculeates, most notably at Elveden.

Trypoxylon attenuatum Smith, F LONG: 95, 97, 00, 01, 03, ELV: 96, 00, 02, 04, SHERW: 95, 96. *Trypoxylon* wasps nest in hollow stems and dead wood.

T. clavicerum Lepeletier & Serville ELV: 96, 97.

T. medium de Beaumont ELV: 04.

T. figulus (L.) sensu stricto WHINF: 03.

T. 'figulus' sensu lato ELV: 95, SHERW: 96, 97.

Apidae

The bee fauna is dominated by ground-nesting solitary species, notably of the genera *Andrena*, *Lasioglossum*, *Halictus*, *Colletes* and *Melitta*, plus their cleptoparasites within the genera *Nomada*, *Sphecodes* and *Epeolus*. Species of the genera *Megachile, Osmia*, *Chelostoma* and *Anthidium* mostly nest in wood and support cleptoparasites such as *Coelioxys* species. *Ceratina* and most *Hylaeus* require hollow stems. *Osmia bicolor* and *Hoplitis spinulosus* use empty snail shells. The quantity and diversity of flowers from March to September has an enormous bearing on the diversity of bees present.

Andrena alfkenella Perkins, R.C.L. **RDB3** ELV: 94, 02, 03, 04. At Elveden, it was associated with calcareous grassland on chalky sand and much foraging appeared to take place on *Pastinaca*.

A. angustior (Kirby) LONG: 02, SHERW: 97. Forages on a variety of flowers.

A. barbilabris Kirby ELV: 02, 03, SHERW: 97, 00. Requires particularly sandy ground for nesting, especially well-trodden footpaths. Forages on a variety of flowers.

A. bicolor F. LONG: 97, 98, 01, 03, 04, ELV: 94, 96, 98, 02, 03, 04, SHERW: 96, 99, 00, 01, 03, 04. Bivoltine, foraging on a wide variety of flowers.

A. bimaculata (Kirby) **N Acidoph** ELV: 02, 03, 04. Bivoltine, the spring generation foraging mainly on *Salix* (with males swarming around flowering *Ulex*), whilst the summer generation uses *Rubus* and umbellifers.

A. cineraria (L.) SHERW: 00, 02, 03. Forages on a variety of spring flowers.

A. clarkella (Kirby) SHERW: 96, 00, 03. Forages exclusively from *Salix*.

A. coitana (Kirby) **Acidoph** LONG: 04.

A. denticulata (Kirby) LONG: 97, ELV: 94, 95, 96, 98, 02, SHERW: 95, 99, 01, 03, 04. Forages from composites such as *Senecio*, *Centaurea* and thistles.

A. dorsata (Kirby) ELV: 94, 95, 98–04. Bivoltine, the spring generation foraging heavily from *Ulex* and *Salix* whilst the summer generation is highly polylectic.

A. flavipes Panzer LONG: 97, 04, ELV: 03, 04. Its late discovery at Elveden corresponds with a marked expansion of its range nationally in recent years. Bivoltine, foraging on a wide variety of flowers.

A. fucata Smith, F. LONG: 96, 00, 01, SHERW: 97, 01, 02. Forages mainly on spring-blossoming shrubs such as *Crataegus*.

A. fulva (Müller in Allioni) ELV: 94, 95, 99, 03, SHERW: 96, 00, 03. Forages on a wide variety of spring flowers.

A. fuscipes (Kirby) **Acidoph** SHERW: 98, 04. Forages entirely from heathers, using *Calluna* in a recently created area of heathland at Sherwood.

A. haemorrhoa (F.) LONG: 95, 96, ELV: 94, 95, 99, 01, 02, 03, SHERW: 96, 00, 02, 03, WHINF: 03. Forages on a wide variety of spring and early summer blossoms and flowers.

A. hattorfiana (F.) **RDB3 Calc** ELV: 03, 04. Forages on *Knautia arvensis*, small amounts of which were present along the south edge of Elveden. It is likely that the individuals recorded here were part of a larger colony based at a nearby site.

A. helvola (L.) SHERW: 97. Forages from a wide range of spring blossoms & flowers.

A. humilis Imhoff **N Acidoph** SHERW: 96, 01. Foraged mainly on *Hypochoeris radicata* here and nested in hard-trodden sandy footpaths.

A. labialis (Kirby) LONG: 01. Forages on Fabaceae.

A. lapponica Zetterstedt **Acidoph** SHERW: 97, 00, 02. Requires reasonable quantities of *Vaccinium myrtillus* in the open or within open-structured woodland. *A. lapponica* may also be present at Whinfell Forest which has the most extensive bilberry of all four sites, but which was not surveyed early enough in spring.

A. minutula (Kirby) LONG: 95, 97, 98, 01, 03, 04, ELV: 94, 95, 96, 97, 98, 01, 02, 03, 04. A bivoltine species that forages on a wide variety of flowers, though umbellifers are utilised heavily by the second generation.

A. minutuloides Perkins, R.C.L. **N Calc** ELV: 02, 03, 04. Most Elveden records related to females foraging on umbellifers such as *Pastinaca*.

A. nigroaenea (Kirby) LONG: 96, 00, ELV: 94, 99, 00, 03, SHERW: 96, 97, 00, 02, 03. Forages on a wide variety of spring blossoms and flowers.

A. nitida (Müller) ELV: 03. Forages on a wide variety of spring flowers. The lack of records for this generally common species is noteworthy.

A. ovatula (Kirby) ELV: 94, 95, 96, 99. A bivoltine species foraging on Fabaceae and relying heavily upon *Ulex* in the spring generation and *Lotus*, *Trifolium* and *Vicia* in the second.

A. praecox (Scopoli) SHERW: 00, 03. Forages exclusively on *Salix*.

A. scotica Perkins, R.C.L. LONG: 96, 00, ELV: 94, 95, 99, 00, 02, SHERW: 97, 00, 02, 03, WHINF: 03, 04. Forages on a wide variety of spring and early summer blossoms and flowers.

A. semilaevis Pérez LONG: 04, ELV: 95, 96, 99, 00, 01, 02, 03, 04, WHINF: 02, 04. Forages on a variety of flowers.

A. similis Smith, F. **N** SHERW: 97, 00. Forages mainly on Fabaceae.

A. subopaca Nylander LONG: 96, 98, 01, 03, ELV: 94, 99. Forages on a variety of flowers.

A. synadelpha Perkins, R.C.L. ELV: 99, 00. Forages mainly on spring-blossoming shrubs such as *Crataegus*.

A. tarsata Nylander **Acidoph** LONG: 97, 02, 03, 04. The Longleat population occurred on restored heathland with plentiful *Potentilla erecta*, the forage plant. Rare in Wiltshire.

A. tibialis (Kirby) **N** ELV: 94, 95, 03. Forages on spring blossoms such as *Salix*, *Sarothamnus* and *Ulex*.

A. wilkella (Kirby) LONG: 98, 01, 04, ELV: 96, 97, 00, 04, SHERW: 96, 97, 01, WHINF: 02, 03, 04. Forages on Fabaceae, especially *Lotus*, *Vicia* and *Trifolium*, the univoltine flight period peaking between the two broods of the related *A. ovatula*.

Anthidium manicatum (L.) LONG: 01, 04, ELV: 02, 04, SHERW: 04. Nearly all records related to females foraging on *Lotus*.

Anthophora furcata (Panzer) ELV: 96, 97, 98. Forages on Lamiaceae.

A. plumipes (Pallas) LONG: 00. A species that can thrive in gardens in spring, typically nesting in walls.

Bombus barbutellus (Kirby) LONG: 03, 04, ELV: 94, 96, SHERW: 04. The social parasite of *B. hortorum* (L.).

B. bohemicus (Seidl) LONG: 97, ELV: 94, 95, 97, 00, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, WHINF: 02, 04 The social parasite of *B. lucorum* (L.).

B. campestris (Panzer) LONG: 00, 03, ELV: 94, 96, 99. The social parasite of *B. pascuorum* (Scopoli) and *B. ruderarius* (Müller).

B. hortorum (L.) LONG: 95, 96, 97, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 03, SHERW: 95, 96, 97, 99, 00, 01, 02, 03, 04, WHINF: 02, 03, 04. Workers particularly favour deep flowers such as *Digitalis*, *Vicia*, *Lotus*, *Stachys* and *Cirsium* and will forage more readily in open woodland than most other bumblebees. The queens of most of the non-parasitic *Bombus* (true bumblebees) listed here require spring blossoming shrubs such as *Salix*, *Prunus* and *Ulex*, and flowers like *Taraxacum* and *Lamium* when they emerge from hibernation.

B. jonellus (Kirby) **Acidoph** SHERW: 03, WHINF: 02, 03, 04. Workers foraged mainly on *Calluna* and *Erica* at these two sites.

B. lapidarius (L.) LONG: 95, 96, 97, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, WHINF: 03, 04. Workers forage heavily on *Lotus* and *Trifolium*.

B. lucorum (L.) LONG: 95, 96, 97, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, WHINF: 02, 03, 04. This species forages heavily on any heathers present. No sign of the closely-related *B. magnus* Vogt at Whinfell (where it might be expected) despite careful screening of *lucorum* specimens.

B. monticola (Smith) **Acidoph** WHINF: 02, 03, 04. Workers forage mainly on *Lotus corniculatus* at Whinfell.

B. pascuorum (Scopoli) LONG: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, WHINF: 02, 03, 04. Workers forage heavily on *Trifolium*.

B. pratorum (L.) LONG: 95, 96, 98, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 01, 02, 03, 04, WHINF: 02, 03, 04. This species is particularly fond of *Rubus* flowers and will use these in thinned-out conifer plantation and broadleaved woodland.

B. ruderarius (Müller) ELV: 94, 95, 97, 03, 04. Workers are easily overlooked amongst *B. lapidarius* and most records relate to males.

B. rupestris (F.) **N* (no status)** LONG: 95, 96, 00, 02, 03. The social parasite of *B. lapidarius*. The males are often abundant on thistle flowers in late summer, but females are less frequently seen.

B. sylvestris (Lepeletier) LONG: 95, 97, 98, 00, 01, 02, 03, 04, ELV: 96, 99, 04, SHERW: 97, 02, 03, 04, WHINF: 02, 03, 04. The social parasite of *B. pratorum* and *B. jonellus*.

B. terrestris (L.) LONG: 95, 96, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 02, 03, 04, WHINF: 02, 03, 04.

B. vestalis (Geoffroy *in* Fourcroy) LONG: 95, 96, 97, 98, 00, 01, 02, 03, 04, ELV: 95, 96, 97, 98, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 03, 04. The social parasite of *B. terrestris*.

Ceratina cyanea (Kirby) **RDB3** LONG: 01. Nests in hollow stems of plants like *Rubus* and *Rosa* in hot locations.

Chelostoma campanularum (Kirby) LONG: 97. At Longleat observed nesting in root plates of fallen conifers and foraging on *Campanularum rotundifolium* within an area of restored heathland.

C. florisomne (L.) LONG: 00. Nests in dead wood and forages exclusively from *Ranunculus* species.

Coelioxys conoidea (Illiger) **Coastal** ELV: 96, 97, 98. *Coelioxys* species are mostly cleptoparasites of *Megachile* bees and tend to be much scarcer then the hosts. This species attacks *Megachile maritima* (Kirby) and like the host, it is more characteristic of coastal dunes.

C. elongata Lepeletier LONG: 04. The cleptoparasite of *M. willughbiella* (Kirby).

C. inermis (Kirby) ELV: 95, 96, 99. The cleptoparasite of *M. centuncularis* (L.).

C. rufescens Lepeletier & Serville **no status* (N)** ELV: 01. A cleptoparasite of *Anthophora* species, presumably *A. furcata* at this site.

Colletes daviesanus Smith, F. ELV: 94, 01, 03, SHERW: 95, 01. Forages on a wide variety of Asteraceae.

C. fodiens (Geoffroy *in* Fourcroy) ELV: 94, 95, 96, 97, 98, 01, 02, 03, 04, SHERW: 95, 98. Forages on a wide variety of Asteraceae.

C. marginatus Smith, F. **N Coastal** ELV: 94, 95, 96, 97, 98, 02, 04. A species associated with very loose sands, typically on coastal dunes but with a significant inland stronghold in the Brecks. Forages on a wider variety of flowers than other *Colletes*.

C. succinctus (L.) **Acidoph** ELV: 95, 96, SHERW: 04. Requires *Calluna* for foraging. Only small amounts of the forage plant occurred at Elveden, and it is likely that the bulk of this population was within the adjacent Lakenheath Warren. The Sherwood population became established following the creation of heathland patches during the 1990s.

Dasypoda hirtipes (F.) **N Coastal** ELV: 04. Requires sandy areas for nesting and forages mainly on *Leontodon*, *Hypochoeris* and similar flowers

Epeolus cruciger (Panzer) ELV: 94, 95, 96, 98, 04, SHERW: 04. A cleptoparasite of *Colletes succinctus* and *C. marginatus*, probably relying mostly on *C. marginatus* at Elveden.

E. variegatus (L.) ELV: 94, 96, 98, 02. A cleptoparasite of *Colletes fodiens* and *C. daviesanus*.

Halictus rubicundus Christ LONG: 95, 96, 00, 01, 03, ELV: 96, 99, 02, SHERW: 95, 99, 00, 01, 03. Forages on a wide variety of Asteraceae.

H. tumulorum (L.) LONG: 95, 97, 00, 01, 03, ELV: 94, 95, 99, 01, 02, 03, 04, SHERW: 95, 98, 01, WHINF: 03, 04. Forages on a wide variety of flowers.

Hoplitis claviventris (Thomson) LONG: 98, 01, ELV: 96, 97, 98, 99, 02, 03, 04. Most records related to foraging on *Lotus*. Nesting occurs in hollow stems.

H. spinulosa (Kirby) **Calc** LONG: 01, 02, ELV: 94, 99, 04. Nests in empty snail shells in sparse turf and forages on a variety of Asteraceae.

Hylaeus annularis (Kirby) **Calc** ELV: 94, 98, 01, 02, 03, 04. Most *Hylaeus* species nest in hollow stems. This species forages on a variety of flowers.

H. brevicornis Nylander LONG: 97, 03, ELV: 94, 95, 96, 02, 03, 04, SHERW: 95, 99, 01. Forages on a variety of flowers.

H. communis Nylander LONG: 97, 98, 01, 03, 04, ELV: 94, 96, 97, 98, 99, 01, 02, 03, 04, SHERW: 96, 01. Forages on a variety of flowers.

H. confusus Nylander LONG: 97, 01, 02, 03, 04, ELV: 03, WHINF: 03. Forages on a variety of flowers.

H. cornutus Curtis **N** ELV: 02, 03, 04. All records were from umbellifer flowers, typically *Pastinaca* and *Heracleum*.

H. pictipes Nylander **N** ELV: 01. Forages on a variety of flowers.

H. signatus (Panzer) **N** ELV: 95, 96, 99, 01, 02, 04. Forages exclusively on *Reseda* sp.

Lasioglossum albipes (F.) LONG: 95, 96, 01, 03, ELV: 98, 99, 01, 02, 04, WHINF: 03, 04. Most *Lasioglossum* species forage on a wide variety of flowers, with some species clearly requiring calcareous grasslands whilst others prefer acidic habitats.

L. brevicorne (Schenck) **N Acidoph** ELV: 99. This species specialises on *Pilosella* and *Leontodon*-type flowers in sandy habitats, typically heathland.

L. calceatum (Scopoli) LONG: 95, 03, ELV: 94, 98, 99, 01, 02, 03, 04, SHERW: 95, 99, 00, 01, 03, WHINF: 02, 03.

L. fratellum (Pérez) **Acidoph** LONG: 95, 96, 97, 00, 01, 02, 03, SHERW: 96, WHINF: 02, 03, 04. Strongly associated with heathland and acid grassland.

L. fulvicorne (Kirby) **Calc** LONG: 03. Strongly associated with calcareous grassland, the Longleat record coming from the only calcareous part of the site.

L. lativentre (Schenck) LONG: 95, 96, 01, ELV: 97, 99, 00, 03, 04.

L. leucopus (Kirby) LONG: 95, 97, 01, 02, 03, ELV: 94, 95, 96, 97, 99, 00, 01, 02, 03, 04, SHERW: 97, 00, 03, WHINF: 02, 04.

L. leucozonium (Schrank) LONG: 95, 96, 97, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 98, 99, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 01. Polylectic but especially fond of *Hypochaeris radicata*.

L. minutissimum (Kirby) LONG: 95, 04, ELV: 94, 96, 98, 99, 02, 03, 04.

L. morio (F.) LONG: 97, 98, 00–04, ELV: 94, 95, 98, 01, 02, 03, 04, SHERW: 97, 03.

L. parvulum (Schenck) LONG: 95, 96, 97, ELV: 94, 95, 96, 99, 04, SHERW: 04.

L. punctatissimum (Schenck) LONG: 95, 96, 97, 98, 00, 01, 02, 03, ELV: 94, 95, 96, 97, 98, 99, 00, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 04.

L. quadrinotatum (Kirby) **N** ELV: 94, 95, 99.

L. rufitarse (Zetterstedt) **Acidoph** LONG: 95, 96, 97, 01,02, 04, SHERW: 95, 97, 00, WHINF: 02, 03, 04. Shows a strong preference for heathland and acid grassland.

L. villosulum (Kirby) LONG: 95, 96, 00, 01, 02, 03, 04, ELV: 95, 96, 97, 98, 99, 02, 04, SHERW: 95, 97, 98, 99, 00, 01, WHINF: 02, 03, 04.

Megachile centuncularis (L.) ELV: 95, 99. *Megachile* species typically nest in cavities in wood and hollow stems. Most species forage on a wide variety of flowers, though *Lotus* and *Cirsium* featured in many of the records here.

M. ligniseca (Kirby) LONG: 03, ELV: 94, 95, 02.

M. maritima (Kirby) **Coastal** ELV: 96, 98, 02, 03. A species more typical of coastal dunes.

M. versicolor Smith, F. LONG: 97, 98, 00, 01, 04, ELV: 96, 98, 01, 03, 04.

M. willughbiella LONG: 96, 97, 98, 03, 04, ELV: 95, 96, 98, 01, 02, SHERW: 96, 99, 01, WHINF: 03

Melitta haemorrhoidalis (F.) ELV: 95. At Elveden foraged on *Campanula rotundifolium* on sandy calcareous grassland.

M. leporina (Panzer) LONG: presence here assumed from the presence of the *Melitta*-attacking *Nomada flavopicta* (Kirby) and the lack of forage plants for other known *Melitta* hosts such as *M. haemorrhoidalis*. ELV: 94, 98, 03, 04. At Elveden it foraged mostly on *Trifolium repens* in shorter, annually cut grassland.

Nomada fabriciana (L.) LONG: 97, 98, 00, 01, ELV: 94, 00, WHINF: 04. *Nomada* species are cleptoparasites of ground-nesting solitary bees, typically *Andrena* species. This species attacks *A. bicolor*.

N. flava Panzer LONG: 96, 00, ELV: 94, 95, 99, 00, 02, SHERW: 97, 02. Typically attacking *Andrena scotica*.

N. flavoguttata (Kirby) LONG: 96, 98, 03, 04, ELV: 94, 95, 98, 99, 02, 03, 04. A cleptoparasite of *Andrena minutula*, *A. minutuloides*, *A. subopaca* and *A. semilaevis*.

N. flavopicta (Kirby) **N** LONG: 03, ELV: 98, 02. A cleptoparasite of *Melitta* spp., almost certainly *M. leporina* at the two sites listed based on the host forage plants available.

N. fulvicornis F. **RDB3** ELV: 00, 04, where two of its known hosts were present, *Andrena bimaculata* and *A. tibialis*.

N. goodeniana (Kirby) LONG: 00, 01, 02, 03, SHERW: 97, 00, 02. A cleptoparasite of *Andrena nigroaenea* and *A. nitida*.

N. lathburiana (Kirby) **RDB3* (N?)** LONG: 00, SHERW: 97, 00, 02. A cleptoparasite of *Andrena cineraria*.

N. leucophthalma (Kirby) SHERW: 00, 03. The cleptoparasite of *Andrena clarkella* here.

N. marshamella (Kirby) ELV: 94, 96, 99, 00, 02, 03, SHERW: 97, 00, 02, WHINF: 03. A cleptoparasite of *Andrena scotica*.

N. panzeri Lepeletier ELV: 02, SHERW: 00, 02, WHINF: 03. A cleptoparasite of *Andrena fucata*, *A. helvola*, *A. lapponica* and *A. synadelpha*.

N. ruficornis (L.) LONG: 96, ELV: 99, 02, 03, SHERW: 00, 02. A cleptoparasite of *Andrena haemorrhoa*.

N. rufipes F. ELV: 96, 02, SHERW: 95, 04. A cleptoparasite of *Andrena denticulata* and *A. fuscipes*.

N. signata Jurine **RDB2** ELV: 00, 02. A cleptoparasite of *Andrena fulva* but considerably rarer then the host for reasons that are unclear and are seemingly not related to climate.

N. striata F. SHERW: 97, WHINF: 02, 03, 04. A cleptoparasite of *Andrena wilkella*. Its apparent absence from Longleat and Elveden is noteworthy, as is its abundance at Whinfell, which is far north of the other sites.

Osmia bicolor (Schrank) **N, Calc** LONG: 98, 00, ELV: 94, 96, 99, 00, 02, 03. Nests in empty snail shells in sparse turf. Foraged mainly on *Lotus corniculatus* at these two sites.

O. caerulescens (L.) LONG: 96, 01, ELV: 99, 02, 04, WHINF: 04. Nests in dead wood and cavities in walls. Foraged heavily on *Lotus* at these three sites.

O. leaiana (Kirby) LONG: 01, ELV: 98, 99, 00, 01, 03, SHERW: 01. Nests in dead wood and forages on Asteraceae, especially *Cirsium* and *Centaurea*.

O. rufa (L.) ELV: 99, 02, 03, SHERW: 97. Nests in dead wood and walls, including some of the lodges, and forages on a wide variety of spring flowers.

Panurgus calcaratus (Scopoli) LONG: 03. A ground-nesting bee that forages on Asteraceae such as *Hypochoeris* and *Leontodon*. The Longleat record came from restored heathland.

Sphecodes crassus Thomson **N* (no status)** LONG: 95, 97, 00, ELV: 94, 95, 02, 04. *Sphecodes* species are cleptoparsites of ground-nesting solitary bees, typically *Lasioglossum* and *Halictus*, plus a few *Andrena*. The hosts of this species include *Lasioglossum parvulum* (the coincidence of the two was fairly strong at Centerparcs, but not in places sich as Warwickshire where another host is evidently used).

S. ephippius (L.) LONG: 95, 96, 97, ELV: 94, 95, 96, 98, 99, 00, 02, 03, 04, SHERW: 96, 97, 98, 99, 00, 04, WHINF: 04. A cleptoparasite of *Halictus tumulorum* and *Lasioglossum leucozonium*.

S. ferruginatus Hagens **N** LONG: 95, WHINF: 02. Precise host(s) in Britain uncertain but possibly including *Lasioglossum fratellum* which was numerous at both locations alongside the *Sphecodes*.

S. geoffrellus (Kirby) LONG: 95, 96, 97, 01, 03, 04, ELV: 94, 95, 96, 98, 99, 02, 03, 04, SHERW: 95, 97, 00, WHINF: 04. A cleptoparasite of *Lasioglossum leucopum*, *L. morio* and others.

S. gibbus (L.) LONG: 95, 97, ELV: 95, 96, 98, SHERW: 95, 97, WHINF: 03, 04. A cleptoparasite of *Halictus rubicundus*.

S. hyalinatus Hagens LONG: 95, WHINF: 03, 04. A cleptoparasite of *Lasioglossum fratellum* and *L. fulvicorne* (possibly sharing these species with *S. ferruginatus*, alongside which it frequently occurs).

S. longulus Hagens **RDB3** ELV: 94, 95, 99, 04. Primarily a cleptoparasite of *Lasioglossum minutissimum*.

S. monilicornis (Kirby) LONG: 03, 04, ELV: 94, 95, 96, 99, 02, 03, 04, SHERW: 97, 00, WHINF: 02, 04. A cleptoparasite of *Lasioglossum albipes*, *L. calceatum* and possibly others.

S. niger Hagens **RDB3* (N)** ELV: 04. A cleptoparasite of *Lasioglossum morio*. Its late discovery at Elveden corresponds with a marked expansion of its range nationally in recent years.

S. pellucidus Smith, F. ELV: 94, 99, 03, 04, SHERW: 97, 00. A cleptoparasite of *Andrena barbilabris*.

S. puncticeps Thomson LONG: 95, ELV: 96, SHERW: 97, 98, 99, 01. A cleptoparasite of *Lasioglossum villosulum* and possibly others like *L. brevicorne*.

S. reticulatus Thomson **N** ELV: 95, 96, 98, 99, 02, 04, SHERW: 01. Another cleptoparasite of *Andrena barbilabris* and possibly also *A. dorsata* at Elveden (based on anecdotal observations).

SHORT COMMUNICATION

A record of *Afrephialtes cicatricosus* (Ratzeburg) (Hymenoptera: Ichneumonidae) from South Devon. – In a recent article, Shaw (2006) updated and extended the knowledge of the Pimplinae and Poemeniinae from the Royal Entomological Society (RES) key of Fitton *et al.* (1988). While some species in the RES key were found to be more widespread than supposed, reference was made to it being a matter of concern that for a few species, including *A. cicatricosus*, no recent records had been forthcoming.

I would therefore like to place on record that on 21.viii.1992 I captured a ♀ *A. cicatricosus* flying amongst bushes of *Salix caprea* in a then unmanaged marshy area at Newton Abbot, Devon (SX 8672). Interestingly, Fitton *et al.* state that the then three records of this species were from the adjacent county of Dorset and that it had been reared from the sesliid moth *Synanthedon formicaeformis* (Esper) – which feeds in Salix wood. I have not seen further examples of *A. cicatricosus* on subsequent field trips to this now somewhat managed area. – A. A. ALLEN, 20, Kingsdown Crescent, Dawlish, Devon.

REFERENCES

Fitton, M. G., Shaw, M. R. & Gauld, I. D. 1988. Pimpline Ichneumon-flies Hymenoptera, Ichneumonidae (Pimplinae), Handbooks for the Identification of British Insects, **7**(1), 1–110.

Shaw, M. R. 2006. Notes on British Pimplinae and Poemenliinae (Hymenoptera: Ichneumonidae) with additions to the British list. *British Journal of Entomology and Natural History* **19**: 217–238.